PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-228663
(43)Date of publication of application : 07.09.1993

---

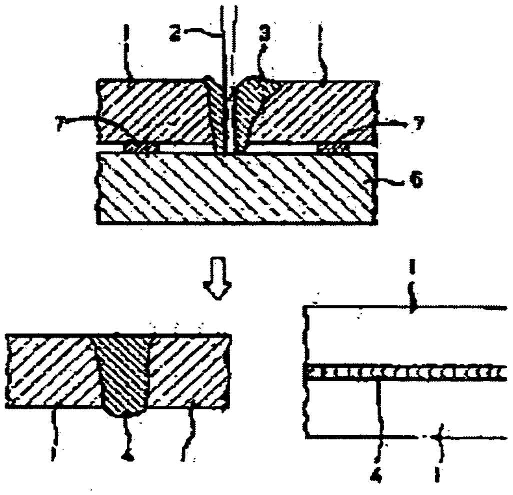
(51)Int.Cl. B23K 26/00
B23K 37/06

---

(21)Application number : 04-046031
(22)Date of filing : 31.01.1992
(71)Applicant : **SUMITOMO METAL IND LTD**
(72)Inventor : **YAMAMOTO TAKESHI**

---

(54) PENETRATION WELDING METHOD FOR ALUMINUM ALLOY BY MEANS OF LASER BEAM



(57)Abstract:

PURPOSE: To control the generation of welding defects, to enlarge the optimum range of welding conditions and to stably obtain sound joints.

CONSTITUTION: At the time of penetration welding of a material to be welded 1, 1 composed of aluminum alloy by means of a laser beam 2, a backing material 6 is provided on the back side of the part to be welded. The backing material 6 is 5wt.% or less in total alloy elements, Mg+Zn<0.5wt.% of aluminum and away from the material to be welded 1, 1 by 50μ m or more.

CLAIMS

[Claim(s)]

[Claim 1] The piercing welding method of the aluminium alloy by the laser beam characterized by separating from welded material 50 micrometers or more of backing materials which the amount of total alloy elements is less than [5wt%], and become the background of a welded part from Mg+Zn<0.5wt% aluminum, and installing them in case piercing welding of the welded material which consists of an aluminium alloy is carried out by the laser beam.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the piercing welding method of the aluminium alloy by the laser beam used for board junction with the assembly of the automobile which uses an aluminium alloy, a rail car, the aircraft, a building, etc., and the production line of an aluminium alloy board etc.

[0002]

[Description of the Prior Art] In recent years, in manufacture of an automobile, a rail car, etc., introduction of an aluminium alloy is advanced for lightweight-izing of the body. In connection with this, development of the welding process of an aluminium alloy is also furthered by every place, and it is becoming clear by the latest research that the piercing welding by the laser beam may become the effective welding means of an aluminium alloy.

[0003] A weld zone with few [the piercing welding by the laser beam has small heat deformation, and] segregations by rapid solidification can be obtained, and it is already widely used for a ferrous material, especially butt welding of sheet metal. In the case of butt welding of a ferrous material, if even the precision of a joint geometry and the precision of comparison are secured, since the keyhole formation by the laser beam will take place stably and heat will be regularly transmitted from a keyhole side attachment wall to molten metal, the penetration stabilized extremely is acquired. Therefore, the proper condition ranges about a laser output and the speed of travel are latus. However, this point is being conquered by the high increase in power of VCO, improvement of condensing optical system, etc. although welding was made difficult until now from the reflection factor of a laser beam being high in the case of an aluminium alloy.

[0004]

[Problem(s) to be Solved by the Invention] However, although the piercing welding of the aluminium alloy by the laser beam became possible, if the viscosity of molten metal has a large heat gain for a low reason, it will melt, will become an omission bead and will reduce the flexural strength of a weld zone remarkably. If a heat gain is made small, remarkable reflection of a laser beam takes place, melting becomes unstable immediately, the way piece of a back bead will arise and this will also cause [of flexural strength] a fall. Therefore, the proper condition range was very narrow and it was very difficult to obtain a reliable healthy welded joint stably. Although the technology of making insertion material, such as a pure aluminium which removed the low-boiling point alloy element, placed between weld zones is indicated by JP,2-307691,A in order to cancel this difficulty, the on-the-strength fall of the weld zone by mediation of insertion material cannot be avoided.

[0005] The purpose of this invention welds aluminium alloys directly, and is to offer the piercing welding method of the aluminium alloy by the laser beam which can moreover obtain a healthy welded joint stably.

[0006]

[Means for Solving the Problem] Examination was advanced for the proper condition range's spreading by leaps and bounds when the way piece of an according [this invention person] to melting ununiformity back bead although the way piece of an according [will melt, if a heat gain is large as mentioned above in laser welding of an aluminium alloy, an omission bead arises, and] to melting ununiformity when heat gain is small back bead arises also melts in fact, omission is the cause, it melted and omission could be prevented, and being able to obtain a healthy welded joint stably. Consequently, the knowledge of melting and omission prevention becoming the effective means of stable welding by the backing material was carried out.

[0007] Drawing 1 is the ** type view showing the process which the way piece of a back bead produces, and, as for welded material and 2, 1 is [a laser beam and 3] molten metal. If molten metal 3 melts and omission starts, the balance of the vapor pressure in a keyhole and the surface tension of molten metal will collapse, lock out of a keyhole will occur, penetration will become shallow temporarily, and the way piece of a back bead will arise by this repeat. Moreover, a blowhole 5 arises in the back bead 4 which the undercut produced on the bead front face between way piece ******, and the back bead 4 projected.

[0008] Then, as shown in drawing 2 , when it welded to the bottom of the welded material 1 and 1 by opening some interval and covering with a backing material 6, at all, the back bead 4 which was followed also in the same laser output and the speed of travel was obtained, and the protrusion of the partial undercut on the front face of a bead or the back bead 4 did not take place, either. 7 is a spacer. If level with the energy density of welding was reached conventionally, since the laser beam absorption coefficient of an aluminium alloy would rise rapidly, when a weld flaw called the way piece and undercut of a back bead increased the energy density, it was considered to be the cause to melt immediately from a ********** field and to shift to an omission field. However, since a backing material 6 is effective in stable formation of the back bead 4, the energy beam density of welding of the cause is not unsuitable, it melts, and it turns out that it is unstable bead formation by omission. Moreover, the effect of reduction in a blowhole and fenestrate prevention is also acquired by use of a backing material 6.

[0009] And the following thing became clear, when it extracted to the backing material and research was continued.

[0010] The piercing welding by the laser beam cannot avoid that penetrate the keyhole and a laser beam appears in a background, though small, since a keyhole is formed. Therefore, a backing material is wanted not to generate a detrimental intermetallic compound, even if it will mix in that the reflection factor of ** laser beam is high, that ** thermal conductivity is good, and ** aluminium alloy, if reuse and joint quality are taken into consideration, since it is heated by irradiation of a laser beam, and welding with the molten metal of an aluminium alloy at an elevated temperature, and suitable [of the aluminum] is carried out from ****. Moreover, it turns out that the molar fraction of the thing containing many low melting point metallic elements, such as Mg and Zn, and aluminum tends to absorb a laser beam for a low thing about **. Furthermore, when the backing material was stuck to welded material, as shown in drawing 3 , the backing material 6 was welded at the weld zone of the welded material 1 and 1, and the ablation cut the bird clapper the part difficult.

[0011] In case this invention carries out piercing welding of the welded material which was made based on this knowledge and consists of an aluminium alloy by the laser beam, it makes a summary the piercing welding method of the aluminium alloy by the laser beam characterized by separating from welded material 50 micrometers or more of backing materials which the amount of total alloy elements is less than [5wt%], and become the background of a welded part from Mg+Zn<0.5wt% aluminum, and installing them.

[0012]

[Function] The target aluminium alloy [welding process / of this invention] is an aluminium alloy objects for structures, such as 1000 systems of JIS, 2000 systems, 3000 systems, 5000 systems, and 6000 systems, and for an ornament, and makes suitable especially the plate (thickness of 0.2-5mm).

[0013] Having made into less than [5wt%] the amount of total alloy elements in the aluminum which constitutes a backing material, and having considered as Mg+Zn<0.5wt% prevents the absorption to the backing material of the laser beam which a keyhole is penetrated and is irradiated to a background, it is for preventing the melting, and if these conditions are not fulfilled, a backing material welds. Moreover, even if it does not result in welding, a possibility that an intermetallic-compound formation element may mix in the molten metal of welded material from a backing material arises. As such aluminum, the specification material of pure aluminum systems, such as JIS1100, etc. can be used, for example. Moreover, the interval of a backing material and welded material was set to 50 micrometers or more for preventing welding of a backing material. About the upper limit of this interval, it is desirable to make burn-through prevention into 30 or less percent of the board thickness of welded material in general from the ease of carrying out of to carry out effectively and the restraint in the case of welding.

[0014]

[Example] The example of this invention is explained below.

[0015] Ten sorts of backing materials B1-B10 shown in Table 2 were used in carrying out butt welding of three kinds of commercial aluminium alloy boards A1-A3 shown in Table 1 by the piercing welding by the laser beam. The carbon-dioxide-laser VCO and the optical system made from GaAs (focal distance of 127mm) of 5kw were used for welding. A welding condition is shown in Table 3. Welding which does not use a backing material for comparison was also performed. Welding is shown in the existence of the way piece of a back bead, and the result which it melted and was evaluated about the existence of omission, the existence of an undercut, and the existence of welding of a backing material is shown in Table 4.

[0016]
[Table 1]

被溶接材の化学成分（ｗｔ％）

代符(JIS No.)	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
A 1 (1100)	0.05	0.01	0.1	0.01	—	0.01	—	—
A 2 (5083)	0.05	0.01	0.01	0.6	4.8	0.1	—	—
A 3 (6063)	0.4	0.2	0.01	0.01	0.55	0.01	—	0.01

[0017]
[Table 2]

裏当て材の化学成分（ｗｔ％）

代符	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Mg+Zn	ﾄｰﾀﾙ含有率
B 1	0.05	0.02	0.1	0.01	—	—	—	—	0	0.18
B 2	0.05	0.02	0.1	0.01	0.4	—	—	—	0.4	0.58
B 3	0.05	0.02	0.1	0.01	0.7	—	—	—	0.7	0.68
B 4	0.05	0.02	0.1	0.01	1.0	—	—	—	1.0	1.18
B 5	0.05	0.02	0.1	0.01	—	—	0.4	—	0.4	0.58
B 6	0.05	0.02	0.1	0.01	—	—	0.7	—	0.7	0.68
B 7	0.05	0.02	0.1	0.01	—	—	1.0	—	1.0	1.18
B 8	0.05	0.05	2.0	0.1	—	—	—	—	0	2.11
B 9	0.05	0.05	4.0	0.1	—	0.1	—	—	0	4.21
B10	0.3	0.2	5.0	0.5	—	0.2	—	—	0	6.2

____ 本発明条件外

[0018]
[Table 3]

溶接条件

被溶接材	レーザー出力(kw)	溶接速度(cm/分)	アシストガス
A1	4	6	Ar,30 l/分
A2	3	6	
A3	4	5	

[0019]
[Table 4]

No.	被溶接材	裏当て材	クリアランス (mm)	評価				区分
				途切れ	溶け落ち	アンダーカット	溶着	
1	A1	なし	—	×	×	×	—	従来例
2	A1	B1	0.1	○	○	○	○	本発明例
3	A2	なし	—	×	×	×	—	従来例
4	A2	B1	0.1	○	○	○	○	本発明例
5	A3	なし	—	×	×	×	—	従来例
6	A3	B1	0.1	○	○	○	○	本発明例
7	A2	B1	0.1	○	○	○	○	〃
8	A2	B2	0.1	○	○	○	○	〃
9	A2	B3	0.1	○	○	○	×	比較例
10	A2	B4	0.1	○	○	○	×	〃
11	A2	B5	0.1	○	○	○	○	本発明例
12	A2	B6	0.1	○	○	○	×	比較例
13	A2	B7	0.1	○	○	○	×	〃
14	A2	B8	0.1	○	○	○	○	本発明例
15	A2	B9	0.1	○	○	○	○	〃
16	A2	B10	0.1	○	○	○	×	比較例
17	A2	B1	0	○	○	○	×	〃
18	A2	B1	0.05	○	○	○	○	本発明例

____本発明条件外

[0020] When a backing material was not used (3 No.1, 5), it melted, and it fell and the way piece of a back bead and a weld flaw called an undercut arose. Even if it used the backing material, when the composition was unsuitable (No.9, 10, 12, 13, 16, 17), and when it was stuck to a backing material by welded material (No.17), although not generated, welding of a backing material produced the weld flaw. However, when the backing material of suitable composition was separated from welded material and was installed (No.2, 4, 6, 7, 8, 11, 14, 15, 18), welding of a backing material did not produce a weld flaw, either.

[0021]

[Effect of the Invention] Although the piercing welding method of the aluminium alloy by the laser beam of this invention welds an aluminium alloy directly, without using insertion material, it suppresses generating of a weld flaw, so that clearly from the above explanation. Therefore, since there is no on-the-strength fall of the welded joint by use of insertion material and the proper welding-condition range spreads, a reliable healthy welded joint is stabilized and is obtained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the ** type view showing the process which the way piece of a back bead produces.

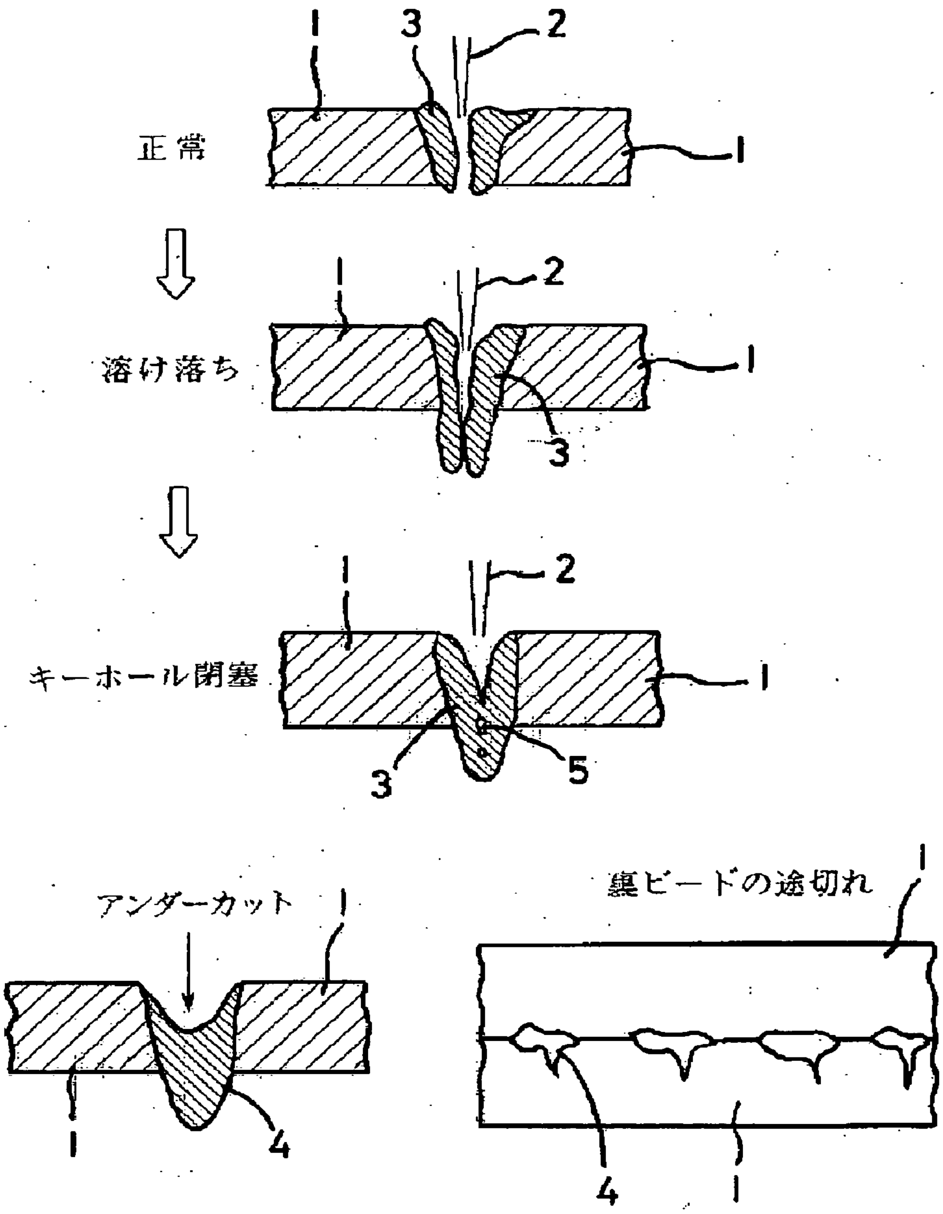
[Drawing 2] It is the ** type view showing welding at the time of using a backing material.

[Drawing 3] It is the ** type view showing welding when the usage of a backing material is unsuitable.

[Description of Notations]

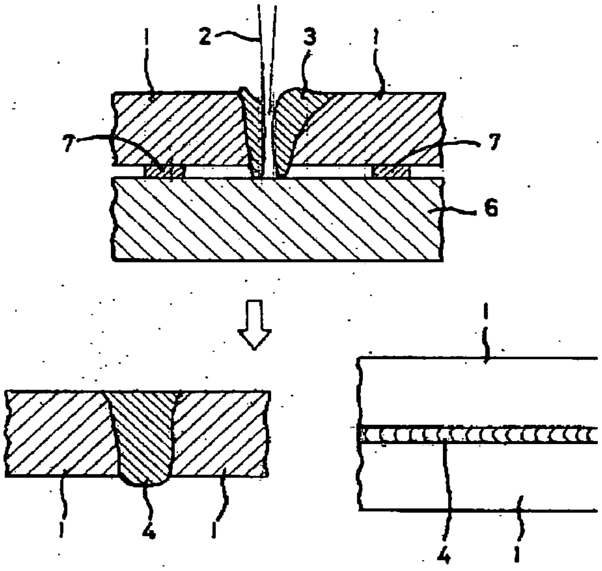
1 Welded Material
2 Laser Beam
3 Molten Metal
4 Back Bead
5 Blowhole
6 Backing Material
7 Spacer

Drawing selection drawing 1 ▼



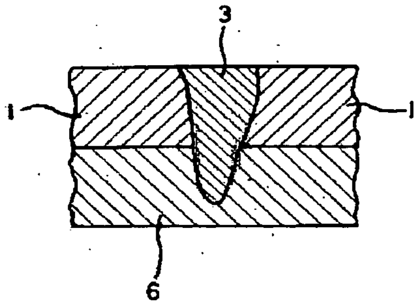
[Translation done.]

Drawing selection drawing 2



[Translation done.]

Drawing selection [drawing 3 ▼]



[Translation done.]